MAASAI MARA UNIVERSITY

REGULAR UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

SECOND **YEAR** ***SECOND*** **SEMESTER**

SCHOOL OF SCIENCES

BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION (SCIENCE)

COURSE CODE: PHY 2214-1

COURSE TITLE: CLASSICAL MECHANICS

DATE: TH APRIL 2024 **TIME: HRS**

INSTRUCTIONS TO CANDIDATES

1. Answer Question **ONE** and any other **TWO** questions
2. *Question one carries 20 marks while each of the others carries 15 marks.*
3. *Credit will be awarded for clear explanations and illustrations.*

*This paper consists of **3** printed pages. Please turn over.*

QUESTION ONE (20marks)

a) What are cyclic coordinates (2marks)
b) Determine the number of degrees of freedom for a rigid body which moves parallel to a fixed to plane. (1mark)
c) Classify each of the following according as they are ;(a)Holonomic and non holonomic constraints;(b) Rhenomic and scleronomic constraints
i. A sphere rolling down from top of a fixed sphere
ii. A particle moving on a very long frictionless wire which rotates with a constant angular speed about a horizontal axis (4marks)
d) Set up Lagrangian for a simple pendulum and obtain an equation describing its motion. (6marks)
e) Let $\boldsymbol{r}'_v$and $\boldsymbol{v}'_v$be respectively the position vector and velocity of particle v relative to the center of mass. prove that $\sum_v m_v r'_v = 0$ (4marks)

f) Prove that the transformation **Q**=**p** and **P**=-**q** is canonical (3marks)

***QUESTION TWO*(15marks)**

a) State Hamilton's principle (2marks)
b) A particle moves in the *xy* plane under the influence of a central force depending only on its distance from the origin.
i. Set up the Hamiltonian for the system (3marks)
ii. Write Hamilton's equations of motion (5marks)

c) Show that for a single particle with constant mass the equation of motion implies the following differential equation for kinetic energy:$\frac{\mathrm{d}\mathbf{T}}{\mathrm{dt}} = \mathbf{F}.\mathbf{v}$, while if the mass varies with time the corresponding equation is$\frac{\mathrm{d}(\mathrm{m}\mathbf{T})}{\mathrm{dt}} = \mathbf{F}.\mathbf{p}$ (5marks)

***QUESTION THREE*(15marks)**

a) Differentiate between conservative forces and non-conservative forces (2marks)

b) State advantages of variation principles formulation (3marks)

c) A particle of mass 2kg moves in a force field depending on time t given by $\boldsymbol{F} = 24t^2\boldsymbol{i} + (36t - 16)\boldsymbol{j} - 12t\boldsymbol{k}$. Assuming that at $t = 0$, the particle is located $\boldsymbol{r}_o = 3\boldsymbol{i} - \boldsymbol{j} + 4\boldsymbol{k}$ and has velocity $\boldsymbol{v}_o = 6\boldsymbol{i} + 15\boldsymbol{j} - 8\boldsymbol{k}$. Find:

i. The velocity (3marks)

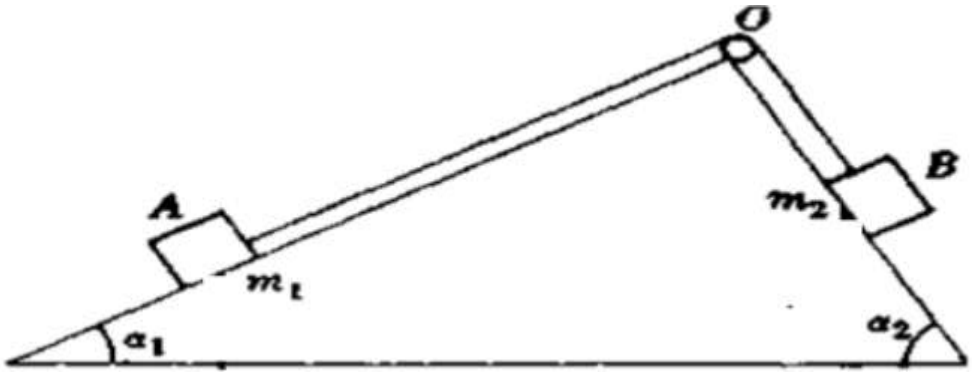
ii. The position (3marks)

iii. The torque about the origin at any time t (4marks)

***QUESTION FOUR* (15marks)**

a) State D'Alembert's principle (3marks)

b) Two particles of masses m_1 and m_2 are located on a frictionless double incline and connected by an inextensible massless string passing over a smooth peg as shown in the figure below.



i. Use the principle of virtual work to show that for equilibrium we must have $\frac{\sin\alpha_1}{\sin\alpha_2} = \frac{m_1}{m2}$ where α_1 and α_2 are the angles of the incline. (4marks)

ii. A system of particles will be in stable equilibrium if the potential V is minimum. Show the above system is not stable (3marks)

iii. Use D'Alembert's principle to describe the motion of masses (5marks)